UNIVERSITI TEKNOLOGI MARA

CHARACTERIZING PHYSICAL PROPERTIES AND MORPHOLOGICAL STRUCTURES OF PEROXIDE-VULCANIZED AND SULPHUR-VULCANIZED NATURAL RUBBER LATEX FILMS

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any other degree or qualification.

I, hereby, acknowledge that I have been supplied the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

The characteristics of the morphological structure of natural rubber latex films prepared from both sulphur and peroxide vulcanization process are visualized under the transmission electron microscope. In sulphur-vulcanized natural rubber latex films, the crosslinked regions appeared as dark areas within the elliptical shaped rubber particles and as strands around the rubber particles section in between rubber particles linking the rubber particles. In peroxide-vulcanized natural rubber latex films, crosslinks region appeared denser at the outer surface of the rubber particles compared to the inner phase. Hydroxyacetone has been shown as an effective activator for tert-buthyl hydroperoxide in the prevulcanization of natural rubber latex using peroxide process. The maximum tensile strength value was observed to occur at film prepared at a prevulcanization temperature of 60 °C, heating for 3 hours. The drying time and temperature play an important role in controlling the strength property of peroxide-vulcanized natural rubber latex films. Crosslink density is not the only factor that contributes to high strength property of natural rubber latex films. The addition of higher levels of crosslinking agent resulting in higher crosslink density and modulus of elasticity values, but, too high crosslinking may lead to subsequent decreased in the tensile strength value. Thus, a combination of the right degree of crosslinking range and the degree of particle cohesion are important factors governing the strength of natural rubber latex films. Leaching treatment and drying at elevated temperature, improved the coalescence of the rubber particles which in turn improved the tensile strength of the films. The addition of antioxidant hinders the thermal-oxidative effect during the drying process and thus, greater coherence of the films by heat treatment could be obtained.

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CHAPTER ONE
INTRODUCTION

1.1 INTRODUCTION AND STUDY RATIONALE

Natural rubber latex is a natural and sustainable industrial material harvested from rubber trees known as *Hevea brasiliensis* (Blackley, 1997; Nawamawat et al., 2011). Natural rubber latex is the material of choice for the fabrication of thin elastic films in many products such as gloves, condoms, catheters, toys, balloons and etc., owing to its high strength, elasticity, comfort in use and 'green image' (Kevin, 1994; Amir Hashim & Rosni, 2009; Adun & Jitladda, 2013). This unique combination of characteristics has its origins from the intrinsic properties of the crosslinked rubber network within the rubber matrix. Crosslinking occurring in the rubber matrix can be either a physical entanglement of polymer chains, or it can be chemically introduced during the product manufacturing process known as vulcanization process (Loh, 1982; Amir Hashim & Morris, 1999; Jobish, et al., 2012). The vulcanization process is carried out in two important stages, which are compounding process and shaping and drying process. Compounding process is a chemical process where many chemicals are involved to promote the crosslinking of the polymer chains. Whilst shaping and drying process is the process that converts the tacky and viscous natural rubber latex into an elastic latex film (Abi Santhosh, et al., 2005; Guillaume, et al., 2011).

The vulcanization process can be carried out either by sulphur vulcanization process or peroxide vulcanization process. In the sulphur vulcanization process, sulphur is added into the natural rubber latex compound as the main crosslinker to form the carbon-to-sulphur crosslinking network between the rubber chains, whilst other chemicals such as zinc diethyl-dithiocarbamate and zinc oxide are functioning as accelerator and activator for the crosslinking reactions (Chong, 1977; Abi Santhosh, et al., 2005; Sureerut, et al., 2012).The use of accelerators and activator is important since both could hasten and enhance the crosslink formation, to obtain the desirable physical properties of natural rubber latex products (Blackley, 1997; Siti Nor Qamarina & Amir Hashim, 2009). Although the sulphur vulcanization process of natural rubber latex has been accepted by the industry for the production of natural